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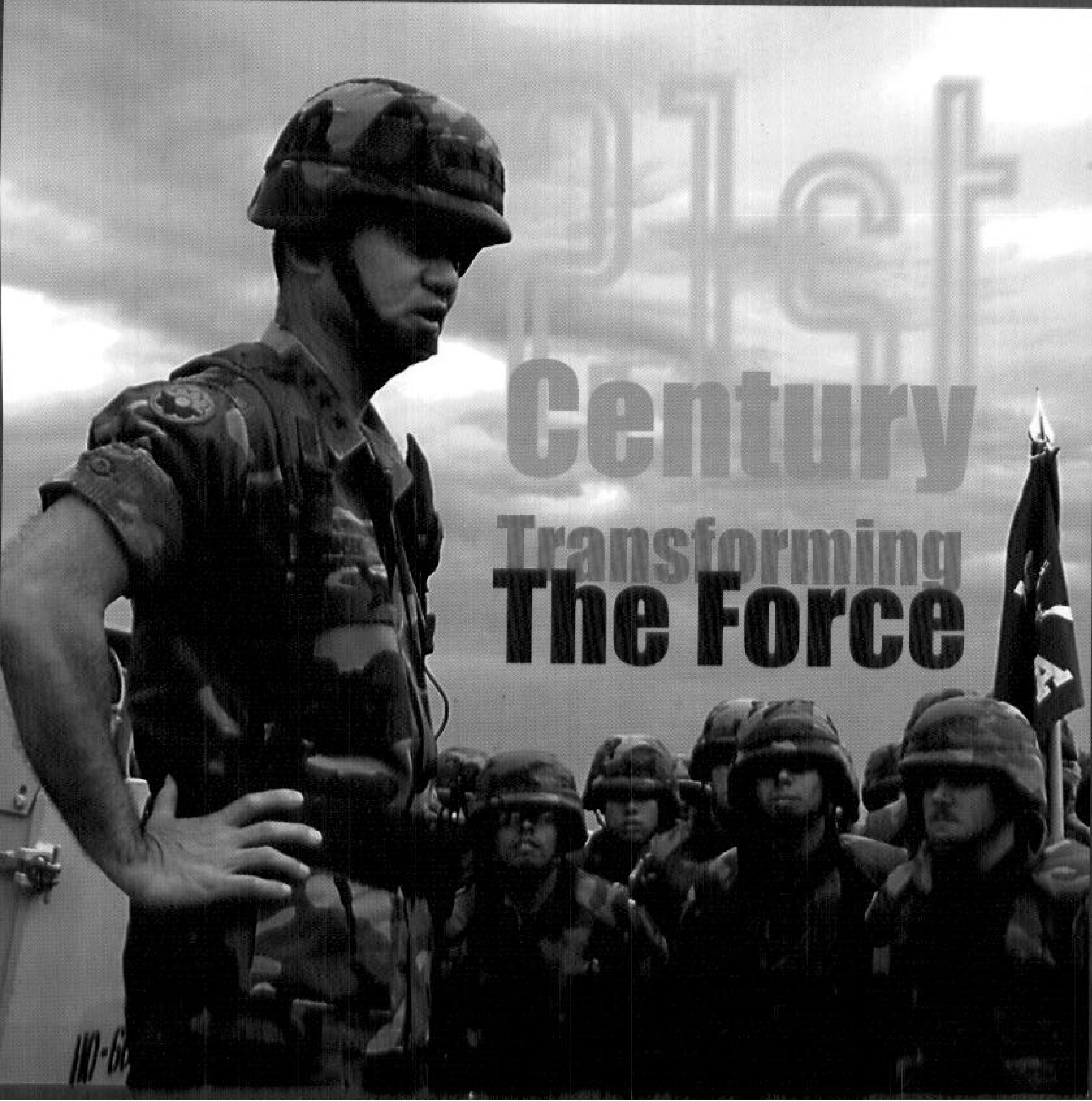
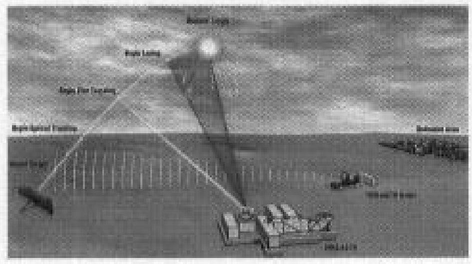


The Tactical High-Energy Laser

The Implications For Future Warfare Of Engaging Targets At The Speed of Light



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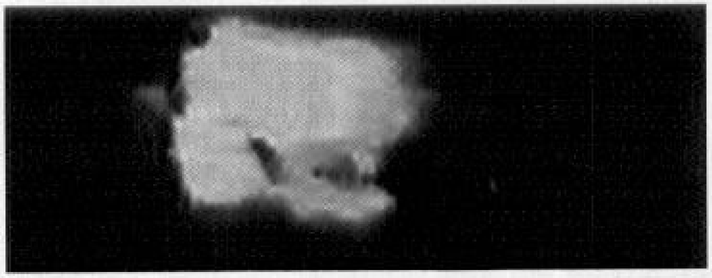
This article is about a breakthrough in warfare—the world's first operational anti-rocket laser. It's called the Tactical High-Energy Laser, and it's the result of a recently completed Advanced Concept Technology Demonstration. Like previous breakthroughs in warfare, at their outset no one really knows their long-term implications, but in this case they are expected to be significant.



On 6 June 2000, a Tactical High-Energy Laser shot down a Katyusha rocket at the Army's High-Energy Laser Systems Test Facility in White Sands, NM. The rocket was launched several miles away. The laser system detected and tracked the 10-foot-long, 5-inch diameter rocket. During tracking, it focused a laser beam on the rocket. Within seconds the rocket exploded.

The Tactical High-Energy Laser represents a big change in warfighting capabilities. This system can rapidly counter not one, but several incoming, short-range rockets. This is new. When faced with such a threat in the past, "the only prayer we had was jumping in the foxhole and praying," stated one individual in the program.

Several features enable this capability. First and foremost, the Tactical High-Energy Laser is fast. Once a target is detected, the system's laser can engage it at the speed of light—literally. Additionally, it can find other targets just as quickly as the first and rapidly re-fire.

The Tactical High-Energy Laser is self-generating, to some degree. It uses a chemical laser, which creates "rounds" from carefully controlled chemical reactions. These reactions can be repeated several times before the chemicals have to be replaced. This gives the laser system a "deep magazine," possibly 30 or more shots. The cost of each shot is relatively low. For the Tactical High-Energy Laser, it's about $3,000.

WHY A TACTICAL LASER?

The Tactical High-Energy Laser grew out of Israel's need to protect its northern populated areas from rocket attacks launched by the Hezbollah in southern Lebanon. In February 1996, the United States and Israel jointly examined the possibility of using lasers to counter this threat. A series of tests were conducted at the High-Energy Laser Systems Test Facility at White Sands using a Mid-Infrared Advanced Chemical Laser, which is a facility-based laser. On 9 February 1996, this laser destroyed an in-flight rocket.

Two months after this demonstration, the White House announced that the United States would help Israel develop a defensive capability against these rocket attacks. It specifically stated that the US and Israel would evaluate the effectiveness of a tactical high-energy laser for this purpose.

The story of how the Tactical High-Energy Laser was achieved is probably as significant as its capabilities. It was ready in only four years—that's fast for a defense program. Knowing how this was accomplished provides insight into how the system works. It also demonstrates the efficacy of a process that can be implemented for future DoD technology transitions.

FAST-TRACK PROGRAM

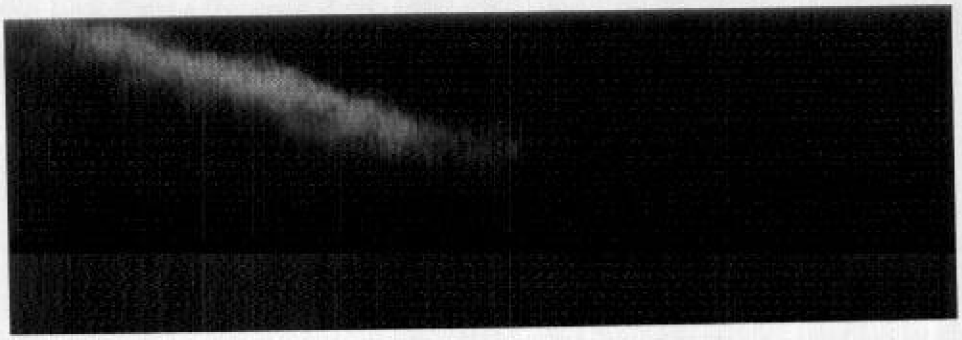
The Tactical High-Energy Laser was made possible by the Advanced Concept Technology Demonstration (ACTD) program, a defense initiative that expedites technology to warfighters. The laser was designated an ACTD in May 1996, making it one of 68 such projects since the program began in 1995. Each one unites scientists and warfighters in an effort to apply technology to an operational concept and quickly determine what is effective.

In the case of the Tactical High-Energy Laser, the US Army Space and Missile Defense Command oversaw this process as DoD's program executive agent. The technology was pursued by a TRW-led team, comprised of US and Israeli subcontractors. This team designed a Tactical High-Energy Laser based on mature technologies. To speed development, the system was built using selected components from several companies.

Essentially, the laser system's components had to enable it to accomplish three primary objectives—detect, track, and destroy a target. The first subsystem was developed for command, control, communications, and intelligence (C^3I) and allows the operator to interface with and control the overall system. It also detects in-flight rockets using an Israeli-made fire-control radar that was integrated into the C^3I subsystem. This subsystem was tested in Israel and at White Sands. In July 1998, the fully integrated C³I subsystem demonstrated that it could detect rockets in flight.

Next, the pointer-tracker subsystem was developed. Once the C³I subsystem detects a rocket, it passes the trajectory information to the pointer-tracker, which tracks the rocket by using optics. As it tracks, this subsystem points the laser at the target. The pointer-tracker was built at TRW's Redondo Beach, CA facility. Upon completion of tests, it was shipped to White Sands, where it was integrated with the C³I subsystem. In October 1999, live-fire tests demonstrated that the C³I subsystem could pass trajectory information to the pointer-tracker and that this second subsystem could track targets.

The final development to be completed was the laser subsystem. The latter uses a deuterium fluoride chemical laser to convert energy from a carefully controlled chemical reaction into a highly directional beam of infrared energy. When focused on the rocket, this energy heats the explosive in the warhead, causing it to explode.



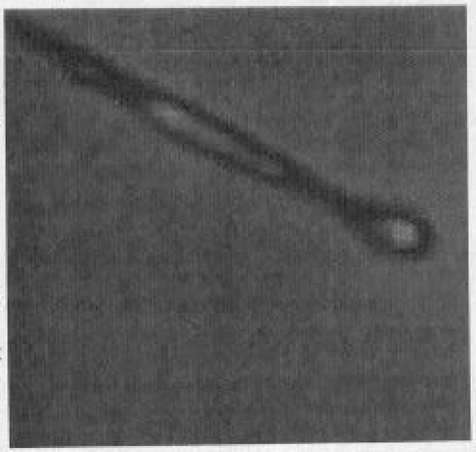
This laser subsystem was developed in three years. It achieved "first light," or emitted photons for the first time, in June 1999 at TRW's Capistrano, CA Test Facility. The laser subsystem was shipped to White Sands, where it was integrated with the other two subsystems.

The result is a transportable Tactical High-Energy Laser. Its subsystems are bundled in several 40-foot containers—a major improvement over the facility-based laser system tested in 1996. Numerous tests were conducted to ensure that all three subsystems were fully integrated. During its June 2000 field tests, the laser system shot down an in-flight Katyusha rocket on its first attempt. On 28 August 2000, the Tactical High-Energy Laser successfully engaged and destroyed multiple Katyusha rockets.

Throughout its development, the Tactical High-Energy Laser was evaluated within a concept of operations. This was provided in the 1996 US-Israeli memorandum of agreement and focused on the system's ability to protect northern Israeli communities from rocket attack. This became the measure of effectiveness during all laboratory and field experiments.

GREATER EXPECTATIONS

From the ACTD program's perspective, the Tactical High-Energy Laser is done. It has met all previous expectations, and Israel can use it when needed. However, one question remains—what impact will this directed-energy system have on the future of warfare? The question is reminiscent of the one posed when the airplane was first introduced to military operations, and many people initially perceived it as a scouting vehicle. The airplane's full value was only realized over time. That's likely to be the case with the Tactical High-Energy Laser.



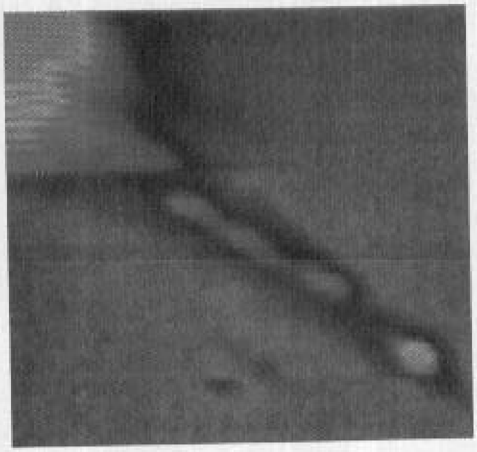
Already some envision that this laser system will be used to protect US forces. In this context, it is seen as complementing a vast array of other weapons systems in a short-to-medium-range air defense architecture. Kinetic-energy weapons would engage threat targets at extended ranges, with the Tactical High-Energy Laser providing more close-in protection.

A more mobile version of the Tactical High-Energy Laser, which will require overcoming some physics challenges, was examined by the Army Air Defense Artillery Center during Exercise Roving Sands '98 at Ft. Bliss, TX. The Center specifically evaluated the system for its ability to do two things: defend against rockets, artillery, mortars, and ground-launched cruise missiles; and complement other cruise missile defenses.

This evaluation was accomplished using simulations for air defense, with attention devoted to modeling the Tactical High-Energy Laser. In one scenario, three platoons of four units each were deployed around two corps command posts and an airfield was occupied by the 6th Cavalry. Several simulated attacks were conducted against these positions. In these simulations, the laser system demonstrated a 90 to 100 percent success rate against a coordinated attack with ground-launched cruise missiles. It demonstrated an 80 to 90 percent success rate against rockets, mortars, and artillery rounds.

Some also see broad applications for directed-energy systems. In the aftermath of the Tactical High-Energy Laser's successful test, Lt. Gen. John Costello, who heads the Army's Space and Missile Defense Command, stated that "directed energy systems have the potential to play a significant role in defending US national security interests world-wide."

That is also the view of the recently published Department of Defense Laser Master Plan. It was conducted in response to the significant advances being made in such DoD programs as the Airborne Laser,



the Space-Based Laser, and the Tactical High-Energy Laser. This plan found that "HEL systems are ready for some of today's most challenging weapons applications, both offensive and defensive." It also states that they "offer the potential to maintain an asymmetric technological edge over adversaries for the foreseeable future."

WHAT'S NEXT?

Shortly after World War II, an air defender wrote: "No antiaircraft artillery man will ever be satisfied until he has a weapon with a muzzle velocity equal to the speed of light and a kill probability factor of 100 percent." The idea is no longer in the realm of science fiction. We've come pretty close to that with the Tactical High-Energy Laser. Moreover, this system and other directed-energy weapons are here to stay. The challenge now is to discern their implications for warfare over the next 50 years. ■